

The Relationship between Temperament, Somatotype and Some Anthropometric Variables and Prevalence of Musculoskeletal Injuries in Military Pilots: A Cross-Sectional Study

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Abstract

Background and Objective: Musculoskeletal disorders are considered the primary health problem among military pilots. Thus, the aim of this study was to investigate the relationship between temperament, Somatotype and some anthropometric variables and prevalence of musculoskeletal injuries in military pilots.

Material and Methods: In this cross-sectional study which was conducted in 2020, in Tehran, 100 military pilots from selected Air Force bases were participated. Prediction of injury was assessed by functional movement screen test. The pilots' temperaments were determined by the standard natural temperament questionnaire. Somatotype was calculated using the Heath-Carter method. Anthropometric data were also collected. The relationship between variables was evaluated by Pearson correlation coefficient and multiple linear regression and the difference between different temperaments in the values of variables was evaluated by one-way ANOVA ($P < 0.05$).

Results: The mean age, weight and functional movement screen score of the pilots were 34.36 ± 5.94 , 84.68 ± 8.55 and 17.99 ± 1.59 , respectively. Between cold and wet temperament ($P = 0.01$), endomorphic component of somatotype ($P = 0.001$), weight ($P = 0.001$), Body mass index ($P = 0.001$), waist ($P = 0.001$), hip ($P = 0.001$), flexed arm ($P = 0.004$) and calf ($P = 0.006$) circumference had a significant negative relationship with functional movement screen test score. Functional movement screen test showed a significant positive relationship only with ectomorphic component ($P = 0.001$). There was no significant difference between different temperaments in functional movement screen test score ($P = 0.64$). Multiple linear regression showed a significant negative relationship only between functional movement screen test score and endomorphic component ($P = 0.01$).

Conclusion: According to the results, it can be concluded that cold and wet temperament, weight, body mass index and endomorphic component of somatotype as individual characteristics are important factors that inversely related to functional movement screen test score of military pilots that should be considered.

Keywords: Temperament, Somatotypes, Injuries, Iran, Cross-Sectional Studies

Introduction

Following the encouragement of general population to participate in sports activities, the number of people who are at risk of injury has increased. With the increase in prevalence of injuries, identifying the factors that predispose a person to injury and their prevention is very important (1). Physical fitness is very important for the military forces, and they must have the optimal level of physical fitness, which can only be achieved through exercise training and physical activity (2). On the other hand, musculoskeletal injuries are the most common medical cause of militaries unpreparedness, and understanding the intrinsic risk factors that may put an elite military at risk of injury can help to prevent musculoskeletal injuries, and it is beneficial to maintain combat readiness of militaries and their employer organization (3). Musculoskeletal disorders are considered the primary health problem among military pilots (4). Research on military aircrew has also shown that maintaining good physical condition is a preventive safety measure against musculoskeletal injuries that should be considered by military pilots (5). Several risk factors have been identified that are involved in increasing the risk of musculoskeletal injuries, which some of them are temperament (6), somatotype (7) and body mass index (8).

According to the theories of traditional Iranian medicine, a person's temperament determines his physical, mental and emotional characteristics; Therefore, the tendency to physical activity, which is considered as a behavior, can be related to a person's temperament and it can be regarded as individual differences (9). Ibn Sina says that, the temperament of each person determines his ability to perform a particular sport, which

if not paid attention to his temperament, the person will be harmed, and the reason is that the person goes out of balance of temperament, and increase the amount of a type of temperament in him (10). Moreover, it seems those who have dry temperament if perform prolong or strenuous exercise are prone to dryness, muscle spasm and cramp. On the other hand, hot-temperament people are neurologically more irritable and are more likely to lose concentration than cold-temperament people, which in turn is considered to be effective in the risk of injury (6). Osborne et al. (2009) in a study in the United States showed that there is a relationship between the severity of injury and temperament in professional hockey athletes (11). In addition, the results of a study by Javan et al. (2016) showed an association between temperament and the incidence of shin splints injury. They recommended that people's temperament be taken into account to prevent injuries such as shin splints (12).

The Functional movement screen (FMS) Test is a tool that developed by health and fitness experts to assess the quality of movement patterns before engaging in physical activity for the active population of communities (13). This test plays an important role in predicting sports injuries and it is applied as a practical, simple to use and highly valid test to predict the occurrence of injuries in the armed forces (1). In a study conducted by Kennedy et al. (2013) on military personnel, they reported that the percentage of body fat and waist circumference inversely affect the FMS test score of militaries, so that militaries with higher fat percentage achieved lower FMS scores (14). However, high body fat percentage and body mass index (BMI) are considered as risk factors for incidence injury among the militaries (15). It seems that high

body mass can reduce mobility, flexibility and balance (16).

Since, musculoskeletal injuries have been cited as the most common medical cause of military unpreparedness (3), examining the inherent risk factors that may predispose a military pilot to injury can be useful in preventing injuries and maintaining combat power and readiness of military Pilots.

On the other hand, due to the lack of research on the risk factors involved in predicting the prevalence of musculoskeletal injuries in the community of military pilots, as a strategic force, it is necessary to study the risk factors in determining the prevalence of injury due to participation in physical activity in order to maintain the health of military pilots. Thus, the aim of the present study was to investigate the relationship between temperament, Somatotype and some anthropometric variables and prevalence of musculoskeletal injuries in military pilots.

Materials and Methods

Study Population

In this cross-sectional study, which was conducted in 2020 in Tehran, 100 active military pilots serving in the Air Force bases with the average age of 34.36 years old were selected as a statistical sample in an accessible and purposeful manner. All measurements were performed between 8 AM to 12 PM. After describing the goals and potential risks of the study by the researchers, the pilots completed a medical history questionnaire and the informed consent form and voluntarily participated in this study. The presence of any musculoskeletal injury or history of bone and joint surgery were the exclusion criteria. The participating pilots did not have any injuries, meniscus lesions, ligament rupture, or surgery on the trunk,

upper and lower limbs. The sample size was determined by taking into account the power 87% by G*power statistical sampling software version 3, based on a study by Safari et al (2019) (17).

According to the schedule, pilots were asked to go to their physical education office to collect study data and physical measurements. First, the steps of study were described for the pilots in detail, and then, the anthropometric characteristics and body composition of the pilots were assessed and information was recorded to determine the pilots' somatotype. Anthropometric data were measured at rest. In order to determine the temperament, the pilots were asked to carefully read the standard temperament questionnaire and answer the questions. In the present study, functional movement screen test was used as a test with high validity in predicting the prevalence of musculoskeletal injuries (1, 18).

Functional movement screen test

First, the researcher explained to the subjects how to perform the functional movement screen test, and after 5-minute warm-up with stretching exercise, the pilots performed the functional movement screen test and their scores were recorded. The functional movement screen consists of seven tests, including the deep squat, hurdle step, in-line lunge, active straight-leg raise, trunk stability push-up, rotary stability, shoulder mobility. The evaluation is done as a qualitative evaluation through a four-point scoring system from zero to three. According to the instructions of Cook et al. (2006), The scoring method is such that, creating pain when performing the tests is zero point, Inability to perform movement with compensatory movements 1 point, perform movement with compensatory movements 2 points and 3 points are given for perform the movement

correctly without compensatory movements. To calculate the total score of the functional movement screen test, the scores of all seven tests are added together. The maximum score in this test is 21, and a score less than 14 indicate that the person is prone to injury (1, 18). Teyhen et al. (2012) reported moderate-to-good Intrarater (Intraclass correlation coefficients = 0.76) and interrater reliability (Intraclass correlation coefficients = 0.74) for the functional movement screen test (19).

Somatotype evaluation

Heath-Carter method was used to determine the somatotype and its components (20). To determine the somatotype by Heath-Carter method, anthropometric measurements including height, weight, humerus and femur breadth, flexed arm and calf circumference and skinfolds of four areas (triceps, subscapular, supraspinale and calf) were measured and recorded. Researchers in the Heath-Carter method have expanded their measurement scale from 1 to 9, so very fat, very thin and very muscular groups can also be examined in this method (21). In order to reduce the human error coefficient and increase the computational accuracy of the collected data to determine the somatotype and preparing the pilots' somatochart, the calculations were performed by somatotype calculator software version 1.2.

Determination of temperament

Pilots' temperament was determined by a standard natural and transverse temperament questionnaire. This questionnaire was designed by Sheikh et al. (2015) (22) to determine the natural temperament, and its validity and reliability have been investigated in Iranian society. The temperament questionnaire consists of 26 questions and each question has different modes related to one of the four temperaments of hot-dry, hot-

wet, cold-dry and cold-wet. In fact, the questions are four-choice and each question can have only one answer. According to this questionnaire, a person's temperament is a temperament that has been present in most of the 26 questions. In assessing the reliability of the questionnaire, Cronbach's alpha was estimated to be 0.85 (22).

Statistical analysis

In this study, mean and standard deviation were used for descriptive statistics (mean±SD). Kolmogorov-Smirnov test was used to evaluate the normality of data distribution. The relationship between variables was evaluated by Pearson correlation coefficient and multiple linear regression and the difference between different temperaments in the values of dependent variables was evaluated by one-way analysis of variance and the significance level was considered $P < 0.05$. SPSS software version 17.0 (SPSS Inc., IBM, Chicago, IL, USA) was used for statistical analysis.

Ethical considerations

Ethical considerations, according to the Helsinki Declaration, were observed by the researchers and the pilots were assured that their information would be kept confidential. Questionnaires and study forms were collected anonymously and coded, and the participation of pilots in this study was voluntary. Present study approved by the Research Ethics Committee of the Jahrom University of Medical Sciences (Ethics code: IR.JUMS.REC.1399.105).

Result

According to demographic and anthropometric findings, the mean age, height, weight and BMI of the pilots participating in this study were 34.36 ± 5.94 , 180.3 ± 4.8 , 84.68 ± 8.55 and 25.95 ± 2.31 ,

respectively (Table 1). The results of FMS test and pilots somatotype are also presented in Table 2. According to Figure 1, the mean somatotype of pilots was in the endomorphic range.

Descriptive results of temperament showed that 8% of pilots had hot and dry temperament, 19% had hot and wet temperament, 6% had mild temperament and 67% had cold and wet temperament. Based on the findings of Pearson correlation test, a

significant negative relationship was observed between temperament and FMS test score only in cold and wet temperament ($r = -0.27$, $P = 0.01$) (table 3). One-way analysis of variance did not show a significant difference between different temperaments in the FMS test score ($F = 0.56$, $df = 3$ and $P = 0.64$). In addition, the sub-findings of the study indicated a significant positive relationship between cold and wet temperament and BMI ($r = -0.3$ and $P = 0.005$).

Table 1: Demographic and anthropometric characteristics of subjects

Variables (n = 100)	Mean \pm SD
Age (years)	34.36 \pm 5.94
Height (cm)	180.3 \pm 4.8
Seat height (cm)	92.67 \pm 4.77
Weight (kg)	84.68 \pm 8.55
Center of gravity height (cm)	87.62 \pm 3.84
BMI (kg/m ²)	25.95 \pm 2.31
Waist circumference (cm)	94.74 \pm 6.79
Hip circumference (cm)	101.83 \pm 5.6
WHR	0.93 \pm 0.03
Flexed arm circumference (cm)	33.23 \pm 3.08
Calf circumference (cm)	37.71 \pm 4.58
Humerus breadth (cm)	7.52 \pm 1.14
Femur breadth (cm)	9.26 \pm 1.07
BMI = body mass index; WHR = waist-to-hip ratio.	

Table 2: Means \pm Standard Deviations for total FMS test scores and somatotype components of subjects

Variables	Mean \pm SD
FMS test score	17.99 \pm 1.59
Ectomorphic component	1.62 \pm 0.87
Mesomorphic component	4.75 \pm 1.85
Endomorphic component	6.02 \pm 1.42
FMS = functional movement screen.	

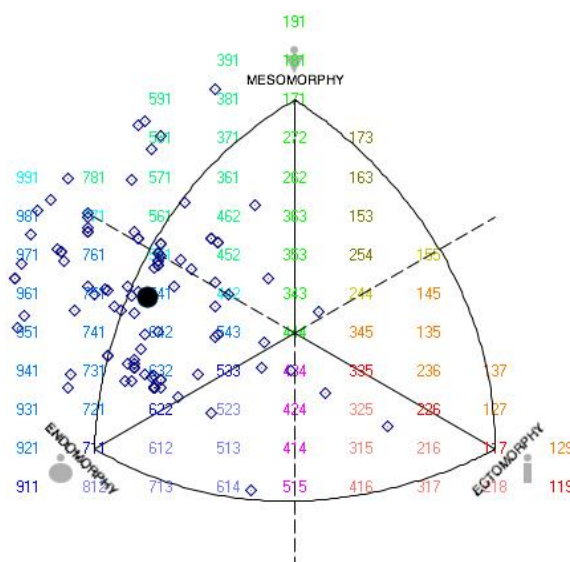


Figure 1: Mean and distribution points of pilots’ somatotype on somatochart (The black circle is the mean point).

Table 3: Pearson correlation between different temperaments and somatotype components with pilots' FMS test score

Variables	Correlation coefficient (r)	P value
Hot-dry temperament and FMS	0.21	0.052
Hot-wet temperament and FMS	0.12	0.24
Cold-wet temperament and FMS	-0.27	0.01*
Cold-dry temperament and FMS	0.1	0.34
Ectomorphic component and FMS	0.32	0.001*
Mesomorphic component and FMS	-0.06	0.49
Endomorphic component and FMS	-0.37	0.001*

* Denotes significant correlation between variables (P < 0.05).

Findings of Pearson correlation test also showed a significant positive relationship between ectomorphic component and FMS test score (r = 0.32, P = 0.001), as well as a significant negative relationship was observed between endomorphic component and FMS test score (r = -0.37, P = 0.001) (table 3); But multiple linear regression (F = 6.45, R = 0.41, Beta = -0.27, 95% Confidence interval for mean (5.74, 6.3) and P = 0.001) showed a significant negative relationship with FMS

test score only in endomorphic component (P = 0.01) (Table-4).

Based on the findings, a significant negative relationship was observed between weight (r = -0.36, P = 0.001), BMI (r = -0.38, P = 0.001), waist circumference (r = -0.4, P = 0.001), hip circumference (r = -0.38, P = 0.001), flexed arm circumference (r = -0.28, P = 0.004) and calf circumference (r = -0.27, P = 0.006) with FMS test score (Table-5).

Table 4: Multiple linear regression for FMS score and somatotype components.

Variables	Unstandardized Coefficients	Standardized Coefficients	95% Confidence Interval for Mean		t	P value
	B	Beta	Lower Bound	Upper Bound		
Ectomorphic component	0.4	0.22	1.44	1.79	1.79	0.07
Mesomorphic component	0.1	0.11	4.38	5.11	1.12	0.26
Endomorphic component	-0.31	-0.27	5.74	6.3	-2.44	0.01*

* Denotes significant ($P < 0.05$).

Table 5: Pearson correlation between anthropometric factors and pilots' FMS test score

Variables	Correlation coefficient (r)	P value
Height	-0.08	0.39
Seat height	-0.05	0.62
Weight	-0.36	0.001*
Center of gravity height	-0.04	0.65
BMI	-0.38	0.001*
Waist circumference	-0.4	0.001*
Hip circumference	-0.38	0.001*
WHR	-0.18	0.06
Flexed arm circumference	-0.28	0.004*
Calf circumference	-0.27	0.006*
Humerus breadth	0.09	0.37
Femur breadth	0.01	0.87

* Denotes significant correlation between variables ($P < 0.05$).

Discussion

The aim of the present study was to investigate the relationship between temperament, somatotype and some anthropometric indices in predicting the prevalence of musculoskeletal injuries in military pilots. The findings of the present study showed a significant inverse relationship between BMI, weight, endomorphic component of somatotype, waist and hip circumference with military pilots' FMS test score. Some of these findings are consistent with the results of previous studies

(14, 16, 23, 24). Perry et al. (2013) reported that higher BMI was associated with lower FMS scores in adults which is consistent with our study (23). Studies by Koehle et al. (2016) and Mitchell et al. (2016) also showed a significant negative relationship between BMI and FMS test score (16, 24). Kennedy et al. (2013) in a study on military personnel showed that waist circumference and body fat percentage were inversely related to FMS test score (14). The results of all these studies were consistent with the results of our study. However, Kelch and Gulgin (2017) in a study examined the correlation between somatotype

and FMS test scores in healthy young people that their findings were not consistent with the findings of the present study. They did not find a significant relationship between BMI and FMS test score. In addition, their findings did not show a significant relationship between somatotype components and FMS test score (13). While, the findings of the present study indicated a negative relationship between the endomorphic component, and a positive relationship between the ectomorphic component with the FMS test score of pilots. This discrepancy in the findings may be due to difference in the predominant somatotype of subjects in the studies. Kelch and Gulgin (2017) reported that many of their subjects had mesomorph somatotype, which is probably, the higher BMI observed in their subjects was due to higher muscle mass than adipose tissue, and this issue was considered as the reason for the lack of significant relationship between BMI and FMS test scores in their study; whereas, the mean of pilots' somatotype in the present study, which was calculated according to the Heath-Carter method, was in the endomorphic range, which indicates more adipose tissue in pilots' body and difference in the somatotype of the subjects in Kelch and Gulgin (2017) (13) study and our study, that can be the cause of contradiction in the findings. Also, Fox et al. (2013) did not find a correlation between functional movement screen test score and BMI, which this inconsistent with the findings of the present study may be due to the type of subjects, smaller number of statistical samples and the same BMI and age of subjects in their study. The subjects of their study were professional and semi-professional Hurling and Gaelic football players (25).

Another finding of the present study showed that there was a negative and significant relationship between cold and wet

temperament and FMS test score of military pilots, or in other words, cold and wet temperament had an adverse effect on FMS test score as a predictor of musculoskeletal injuries. By searching the literature, no study was found that examined the relationship between temperament and FMS test scores. However, Sardar et al. (2016) in a study on male athletes in light and intensive sports reported that athletes with hot and wet temperaments have the highest rate of injuries and athletes with cold and wet temperaments have fewer amount of injuries caused by sports activities; but they did not observe any significant relationship between the prevalence of sports injuries and athletes' temperament. noteworthy point in the study of Sardar et al. (2016) was that they reported that athletes with hot temperament were more tendency to participate in sports activities and, of course, had more injuries than cold temperament athletes. On the other hand, athletes with cold temperament are less tendency to participate in sports activities due to their temperament characteristics, such as being feeble and weak-kneed, so sports injuries are less in these athletes (6). The sub-finding of the present study showed that there was a significant positive relationship between cold and wet temperament and pilots' BMI. This finding is consistent with the results of a study by Parvizi et al. On the relationship between BMI and cold temperament (26). Since body dimensions is one of the determinant indicators of temperament in traditional Iranian medicine, increase in weight, BMI and soft tissue of the body, which mainly indicate obesity and body fat gain, from the point of view of traditional Iranian medicine, it indicates cold and wet temperament (27). In addition, according to the literature, subject with cold and wet temperament have significantly higher BMI

than subject with hot and dry temperament (26). Given that in both the present and previous studies, an inverse relationship was observed between the FMS test score and BMI (16, 23, 24). Therefore, it seems that the negative relationship between cold and wet temperament with the FMS test score of pilots in the present study is due to the nature of cold and wet temperament (i.e. the tendency to obesity), and fat dominance in pilots' body mass, which has increased BMI and a negative effect on FMS test scores in these individuals.

Screening the militaries before participating in military and exercise activities is necessary due to the possibility of injury during the implementation of such activities (1). Injury incidence, especially in elite military personnel, in addition to the negative economic burden on the military organizations, also affect their combat readiness (28). Numerous studies have examined the relationship between the FMS test and the incidence of injury, and have introduced the FMS score as a predictor of the incidence of injury and have reported that subjects with a score less than 14 in this test are prone to musculoskeletal injuries (1, 29). FMS test, while easy to implement, has a good validity that is able to identify movement defects by evaluating the whole kinetic chain mobility (1). The results of several studies show that body mass index has a negative effect on the score of functional movement screen test and subjects with higher BMI achieve to lower FMS score or in other words, subjects who have a higher BMI are more prone to injury during exercise (16, 23, 24). Even, high body mass index has been cited as a risk factor for neck pain in military personnel (30). This inverse relationship between high BMI and FMS test score seems to be due to the fact that excess body mass

can affect the body mobility, flexibility, stability and balance and ultimately limitation in these factors leads to impaired physical function. In addition, high BMI values that are associated with physical inactivity may result in a poor performance on the FMS test due to the relative lack of physical activity that helps maintain or develop proprioception, balance, neuromuscular control and stability (16).

One of the limitations of the present study was the impossibility of precise control of mental and psychological conditions, including the motivation and anxiety of the subjects during the tests. Security considerations of military pilots made access to these subjects very difficult, which was another limitation of our study.

Conclusion

Finally, based on the findings of the present study, it seems that high body mass index, cold and wet temperament and the endomorphic component of somatotype can have a negative relationship with the pilots' functional movement screen test score, which these factors should be considered by the commanders and sports officers of the Army Air Force, as well as, continuous screening and maintaining optimal body mass index by pilots and paying attention to the pilots' temperament can probably be effective in reducing the risk of injury in pilots during physical activity and it can help them as a strategic military force, to maintain their combat readiness; but further studies with large sample size are needed to confirm these findings.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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